

## Air-to-Air UAV Aerial Refueling

Completed Technology Project (2012 - 2013)



## Project Introduction

Armstrong researchers, in cooperation with Northrop Grumman Corporation and the Defense Advanced Research Projects Agency (DARPA) demonstrated autonomous aerial refueling between two unmanned, high-altitude aircraft. NASA's two Global Hawk UAVs, one outfitted as a receiver and the other as a tanker, flew a series of demonstration flights to validate advanced UAV-to-UAV aerial refueling control system technology. The two Global Hawk aircraft successfully flew for the first time as close as 30 feet in formation. In addition, the aircraft rendezvoused and flew for more than 2.5 hours under autonomous formation control, the majority of time within 100 feet (or one wingspan) of each other. This research effort (referred to as the KQ-X project), is a follow-on to NASA's Autonomous Aerial Refueling Demonstration (AARD) project, in which manned aircraft operating on autopilot functioned as surrogate UAVs to test flight control and optical tracking systems. Work to date: The demonstration flights occurred between January and May 2012 and achieved many milestones. The lead receiver aircraft extended and retracted its aerial refueling hose several times, completing all planned tests to validate the associated program hardware and software. In addition, the trailing tanker aircraft successfully demonstrated precision control in formation with manual and automated "breakaway" maneuvers, which are important safety features and criteria of the test program. Looking ahead: Next steps involve further tests with unmanned aircraft. The team is looking for an industry partner to advance these development efforts. Partners: DARPA, Northrop Grumman Corporation, Sierra Nevada Corporation Benefits In-flight refueling: Allows UAVs to fulfill longer missions with longer flights Increased mission scope: Permits more flexibility in UAV use Long-term station keeping: Reduces the number of take-offs and landings to fulfill a given mission Automated refueling: Relieves pilots of burdensome flight refueling missions Applications UAV refueling Formation flight Automated manned aircraft refueling

## Anticipated Benefits

- **In-flight refueling:** Allows UAVs to fulfill longer missions with longer flights
- **Increased mission scope:** Permits more flexibility in UAV use
- **Long-term station keeping:** Reduces the number of take-offs and landings to fulfill a given mission
- **Automated refueling:** Relieves pilots of burdensome flight refueling missions



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## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

### Responsible Program:

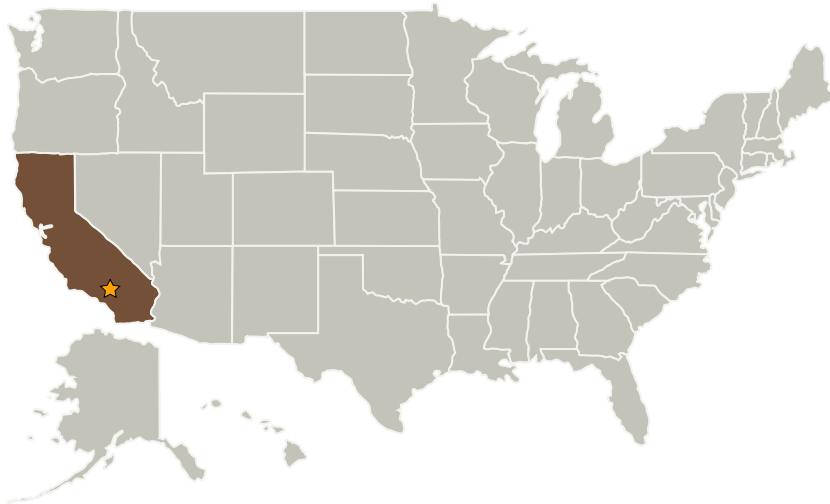
Center Innovation Fund: AFRC CIF

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Armstrong Flight Research Center (AFRC)	Lead Organization	NASA Center	Edwards, California

Co-Funding Partners	Type	Location
Defense Advanced Research Projects Agency (DARPA)	US Government	
Northrop Grumman Systems Corporation	Industry	Falls Church, Virginia
Sierra Nevada Corporation (SNC)	Industry Women-Owned Small Business (WOSB)	Sparks, Nevada

## Primary U.S. Work Locations

California

## Project Management

**Program Director:**

Michael R Lapointe

**Program Manager:**

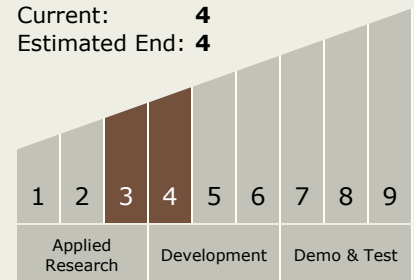
David F Voracek

**Principal Investigator:**

Richard R Larson

## Technology Maturity (TRL)

Start: 3  
 Current: 4  
 Estimated End: 4



## Technology Areas

**Primary:**

- TX15 Flight Vehicle Systems
  - TX15.2 Flight Mechanics
    - TX15.2.3 Flight Mechanics Testing and Flight Operations